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NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION
DURHAM, N. H.

Bulletin No. 250 February—1930

AGRICULTURAL EXPERIMENTS

—1929—

New Hampshire
Agricultural Experiment Station
University of New Hampshire,
Durham, N. H.

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AGRICULTURAL EXPERIMENTS—1929

REPORT OF THE NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION

J. C. Kendall, *Director*

In a world which makes silk stockings out of trees, paper out of cornstalks and fertilizer out of the air, the importance of agricultural research is obvious. The more we become industrialized, the more we depend upon the trained investigator.

Not only is this true of the sciences which directly affect agricultural production. Events move more and more swiftly in the field of economics. Questions of crop margins, of price trends, of land values, of consumer demand, of financial tendencies and of coöperative organization are in the air. There are many problems here of vital importance to the agriculture of each region. The formation of the Federal Farm Board with the tendency to centralize marketing power is a case in point. An alert program of research in agricultural economics is bound to be increasingly necessary; and the development, which has been made possible by the Purnell Fund, has come none too soon.

A broadening of the Station's work to cover more adequately the regional problems of the state is evident, not only in the economic investigations, but also in the soil plots located in five series on representative fields in Rockingham, Merrimack, Sullivan and Coos counties. The importance of a more definite program of research from a state standpoint is clear, and the demands for state service work are increasing in all branches of the industry.

A serious loss to all agricultural experiment stations has been felt by the sudden death in November, 1929, of Dr. E. W. Allen, Chief of the Office of Experiment Stations of the United States Department of Agriculture. For 14 years in this position his advice in regard to all details of Station procedure has been constantly helpful. A most competent and constructive critic, a kind and thoughtful and thoroughly trained executive, he has exerted a profound influence on the projects of this Station as well as those of other states.

In the resident staff there have been few changes during the year. Dr. C. L. Martin was appointed Station veterinarian; Dr. C. A. Bottorff, poultry pathologist; M. A. Campbell, certification inspector of poultry; H. C. Moore, assistant dairyman; L. W. Glover and W. A. Westgate, research assistants in entomology; Nicholas Colovos and Maurice Bickford, assistants in animal nutrition; H. L. Murray, R. B. Dearborn, and C. E. Walker, graduate assistants; L. J. Higgins, assistant agronomist, and F. D. Reed, assistant in agricultural economics. S. R. Shimer was granted a year's leave of absence for study, and his position as assistant chemist has been temporarily filled by A. D. Robinson. E. M. Rowalt has been appointed editorial assistant, and W. W. Shirley librarian.

Already the influence of the Purnell Fund has begun to be felt in the increased number of publications. Prompt report in public form upon the

completion of projects is essential to an adequate system of research; and we are endeavoring to present the accomplishments of the Station not only in comprehensive bulletins but also through press summaries and abstracts in various journals.

Bulletins issued during the year were as follows:

Bulletin 235—Results of Seed Tests, 1928.
" 236—Inspection of Commercial Feeding Stuffs, 1928.
" 237—Inspection of Commercial Fertilizers, 1928.
" 238—Agricultural Experiments, 1928.
" 239—Potato Production Costs in New Hampshire.
" 240—Simplified Technique and Apparatus for Measuring Energy Requirements of Cattle.
" 241—White Mountain Hotel Demand for Vegetables and Poultry Products.
" 242—The Energy and the Protein Content of Foods Regularly Eaten in a College Community.
" 243—Mosquitoes in New Hampshire.
" 244—Electric Household Refrigeration.
Circular 29—Certification of Poultry.
Technical Bulletin 38—Viscosity in Ice Cream Mixes.

POTATO PRODUCTION COSTS

Ability to produce potatoes as efficiently as competing areas, nearness to markets, and deficient production within the state point to an opportunity for many New Hampshire farmers to produce potatoes profitably, M. F. Abell summarizes a two-year study of production costs. The survey was made on 200 farms which raised more than 10 per cent of the potatoes produced in the state. Twelve growers kept detailed labor records in 1927.

It is becoming more and more difficult to justify hand methods. Where the area is small, machinery is too expensive. Only where family labor cannot otherwise be employed, and the yields obtained are exceptionally high, may hand methods be profitable. Where potato machinery is used, savings in labor of three to five days an acre are possible. Areas as small as 3.8 acres proved large enough to handle potato machinery economically. The area in potatoes is one of the most important factors influencing production costs. As the acreage increases, production costs decrease, and high yields are most often associated with the larger areas.

In New Hampshire, for the farms surveyed, the labor requirements on the average are about 15 per cent higher than in Aroostook County, Maine. Seed costs for similar quantities are higher. Fertilizer costs are lower because much manure is used in rotation on our dairy farms. On the other hand many New Hampshire growers have a transportation advantage of 39 cents a hundredweight. Considering the marketing advantage New Hampshire growers have a more favorable position in a comparison of costs, and the crop may be grown as a supplement to the dairy enterprise, as it most often and properly is, while in Aroostook County the farmers are not so favored.

The potato crop of the state is raised largely on the less favorable soils. There is still in New Hampshire a large area best suited to potatoes, particularly in the north. In many cases the potato enterprise seems to be incidental to the dairy business, and therefore a large proportion of the best soils are still available. In the southern counties the farmers are raising potatoes more nearly as a main enterprise, for only on the better soils can they compete in yields with the more favored regions of the north.

FIGURE 1.—Areas as small as 3.8 acres proved large enough to handle economically machinery for potato production.

In 1926 few growers in the north used certified seed. In the south, due to dry weather, the average increase was only ten bushels an acre, yet the increase more than paid for the higher seed costs. In the following year increases of 40 to 50 bushels were noted which much more than paid for the use of the better seed. The amount of seed used varies from 12 to 22 bushels to the acre. An increase in the amount of seed is closely associated with higher yields, yet, under present cultural practices, it seems unwise to use more than 18 to 20 bushels an acre.

The practice of splitting the fertilizer application, even when 2,500 pounds to the acre are used, did not prove profitable.

Further details of the survey are given in Bulletin 239, "Potato Production Costs in New Hampshire." (*Purnell Fund.*)

CONSUMER DEMAND FOR POTATOES

Interviews in 1,050 homes in Manchester, Concord, Franklin, Rochester, Dover and Portsmouth, supervised by E. H. Rinear, indicate that the majority of consumers are forced to buy smaller potatoes than they care to use. The majority of housewives preferred potatoes not less than 2.11 inches in width, which is .11 inch larger than the requirement for U. S. Fancy No. 1 grade and .36 inch larger than for U. S. No. 1 grade.

A decided tendency was found for consumers to buy in small lots the

year around from the corner grocery store—the peck was the most popular measure—even when a good storage is contained in the house. Only 24 per cent of the consumers obtained their supplies direct from the farmer; 40 per cent bought from the chain stores and 36 per cent from other grocers. Nineteen per cent purchased regularly from the same farmer, 32 per cent from the same chain store, and 27 per cent regularly from other grocers.

Consumption of potatoes varies with the income and nationality of the family. Families of Irish and German antecedents, and with larger incomes, consumed less. Families of French extraction, however, consumed more as the income increased. The average yearly consumption of the German families of low income in Manchester was 4.35 bushels, and with a higher income, 2.91 bushels. The average yearly consumption of all persons included in the survey was 3.26 bushels. Seventy-five per cent asserted that increased prices had no effect on the volume of potatoes used; the others were guided by the price.

Whether the source of the potatoes is in New Hampshire or Maine is an indifferent matter to 62 per cent of the housewives; 11 per cent preferred Maine grown potatoes, and 27 per cent preferred the New Hampshire product. Very similar reasons were given for the preference of potatoes from both sources. (*Purnell Fund.*)

WHITE MOUNTAIN HOTEL MARKETS

Opportunity exists for a few market gardeners and poultrymen in northern New Hampshire to supply the summer demand of White Mountain hotels for fresh vegetables and poultry products, finds E. H. Rinear. Lack of uniformity in the grade of products offered, and lack of a dependable supply, have forced the hotel stewards to turn to Boston commission merchants for two-thirds of their poultry and vegetable supplies, according to stewards of ten of the larger hotels which were visited.

The survey shows the hotel demand to be very exacting, requiring the highest quality during a three-months' period. Vegetables are desired which at least equal the requirements of U. S. No. 1 grade, and in many instances of U. S. Fancy grade. Poultry meat from the heavier breeds is preferred because, with relatively more fiber and less connective tissue, the meat is more tender. White feathered heavy breeds are desired for broilers because the white pin feathers and hair follicles do not detract from the appearance when served. In general, dressed poultry which has been milk fed, freshly killed, dry picked, and uniformly graded to size and quality, will meet the White Mountain hotel demand.

The preferences of the stewards for white or brown eggs are equally divided. Eggs of the very best quality are desired for frying, poaching and boiling; those of lower grade are used for cooking and baking. To satisfy their discriminating guests the hotels demand eggs which have yolks of uniform color for frying. A slight difference in color leads the guest to believe one is spoiled. At the present time the majority of the hotels are using a brand of eggs from a source outside the state which is giving satisfaction. Local eggs, the stewards complain, are neither candled nor graded.

Since a large number of the hotels are situated north of the European corn borer quarantine area, many of the stewards are keenly interested in

securing a local supply of green corn. Golden Bantam is the favorite variety. Golden Evergreen, Country Gentleman, and Stowell's Evergreen also received stated preferences. Medium sized ears in fresh green husks are desired. Small, well-filled kernels are preferred. Opinion is divided whether the rows should be straight or zigzag.

The prices for vegetables received by local growers are usually above Boston market quotations. This difference, however, is not all premium, because delivery is made. The stewards, in general, expressed a willingness to pay as much for local products as produce from Boston would cost after all charges are paid.

Several of the hotels have gardens and produce some vegetables. This practice rapidly loses favor when a steward is able to purchase regularly from a local grower. The few gardens kept for show purposes are operated at a loss, the managers state. (*Purnell Fund.*)

COSTS OF RETAILING GRAIN

Analyses of grain store cost accounts of 35 representative businesses, by E. H. Rinear, show an average gross margin of 11.5 cents is taken on each dollar of business, and that a net profit of slightly less than .7 cent is earned on each dollar of sales. Fixed costs, including such items as depreciation, interest on net worth, rent, taxes, and insurance, averaged 2.7 cents per dollar; labor costs averaged 5.3 cents; delivery costs 1 cent; and miscellaneous costs 1.8 cents.

With two exceptions, all stores which had average yearly sales of less than $31,000 for each man employed, and average labor costs above 5.3 cents per dollar of sales, were operated at a loss. The two exceptions had taken gross margins below the average of 11.5 cents.

Labor represents approximately 50 per cent of the total costs, and, when the value of labor distribution is measured in terms of daily sales, some stores are found to be twice as efficient as others.

Even when quotations were given on a cash basis, larger margins were being taken by the stores doing the larger credit business. (*Purnell Fund.*)

ROADSIDE STAND STUDY COMPLETED

Rural roadside stands in New Hampshire which featured farm products showed the largest average sales, according to the study by M. Gale Eastman on roadside marketing. Next in order came tea rooms and gift shops, stands featuring merchandise products and stands featuring homemade products such as pastry, candy, etc.

A full report of the study is being published as Bulletin 249. About 800 stands were visited and figures from 103 of these showed average sales of $2,714. The five largest markets averaged $12,721. (*Purnell Fund.*)

TIME STUDIES IN HAYING AND ENSILING CORN

Six and a half hours is the average labor requirement for raising and ensiling one ton of corn, M. F. Abell finds from a study of roughage production costs on 86 farms producing silage and 54 farms raising hay. The labor requirement for hay is 8.4 hours a ton.

Small size of business is associated with a large requirement of man hours per acre. Farms having four acres of corn require about 80 man hours an acre to raise and ensile. This time demand is reduced to 51 man hours when 17 acres are raised. On hilly land the use of machinery is limited, which is reflected in a 77-hour labor requirement for an acre of corn compared to 57 hours on level land. On 45 per cent of the level farms studied tractors are used, on 60 per cent harvesters, and on 40 per cent two-row planters.

Cutting and binding with a harvester accounts for a saving of 20 to 25 hours an acre. When a low loading rack is used in combination with tractor preparation, machine planting, and harvesting, the labor requirement is 45 hours compared to 78 hours with horse preparation and hand methods.

When hay is raked with a dump rake, stirred out by hand, bunched, loaded and pitched off by hand, the labor requirement is invariably high. If pitched on the wagon by hand, about 12 per cent of the labor of harvesting is saved by bunching with a dump rake. In mechanically equipped barns, unloading by hoist from the center is 14 per cent more efficient than unloading from either end. (*Purnell Fund.*)

TIME STUDIES IN ORCHARDS

Field work in a three-year study of orchard practices pursued on twelve representative southern New Hampshire apple farms is now complete. Each manager, a skilled man intimately acquainted with his job, reported to H. C. Woodworth and G. F. Potter the hours spent each day on each task. The orchard operations were classified under the following heads: Pruning, spraying, brush removal, fertilizing, cultivating, mowing, mulching, thinning, propping, setting, protecting against rodents, and miscellaneous.

Over a third of the 19,000 apple trees on the farms are between 11 and 15 years of age, and very few are more than 20 years old. To place the farms on a comparable basis the equivalent in mature trees was computed for each farm, and the labor requirements for 1,000 such trees were obtained. Figure 2 shows the average number of hours spent in each operation and the percentage of total time required for 1,000 mature trees.

Spraying proved the most important single operation, and the most ex-

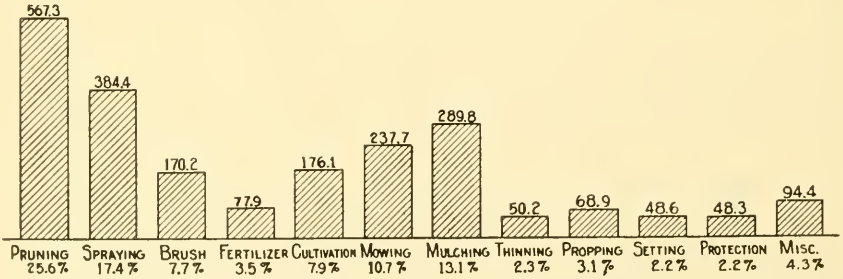

FIGURE 2.—The average number of hours spent in each orchard operation and the percentage of total time required for 1000 mature trees.

pensive if the cost of horse labor is included. Not only does spraying cost more than pruning, but a greater degree of skill is required and the operation must be performed within very definite time limits. Pruning requires the greatest amount of man labor, which is especially true if disposal of brush is included in the cost of the operation.

During the three years of the study most of the trees were under sod mulch culture. Part of the time some were tilled. Propping of the trees in years of heavy crops is practiced in some orchards more than in others. Thinning is done to some extent, but it is evident that the average orchardist considers thinning of value only for certain varieties, such as the Wealthy.

The average cost of production up to harvesting, not including overhead expenses, for the three-year period was 36.13 cents a box. Operating costs for 1,000 mature trees were $2,380, which were distributed as follows: Total labor, $1,120.80; use of trucks, $10.31; cost of spray material, $436.40; cost of fertilizer, $499.42; maintenance of sprayers and dusters, $91.00; and charge for land, $222.22. In computing these costs only the time actually spent by the hired help in the orchard was charged against apple production; overhead expenses are not yet known.

Practices in harvesting, packing and marketing differed much more than cultural practices. Some of the men sold "tree run" to buyers who furnished and delivered the boxes, and carried them away when filled. Such harvest operations are simple and inexpensive. Other growers graded their fruit into four different qualities, separated the first and second qualities into eight different sizes, wrapped them in oiled paper and packed them in a box by hand. After this work is done it is customary for the grower to incur transportation and commission charges. Careful estimates of the costs of harvesting were made and deducted from the gross return. It was found that for three years the apples were worth an average of $.79 a box to the growers before harvesting commenced. From 20 to 25 per cent of the trees in these orchards are McIntosh. (*Purnell Fund.*)

POULTRY TIME STUDIES ARE BEGUN

Weekly visits are being made to 25 representative poultry farms in Strafford, Rockingham and Hillsborough counties by F. D. Reed to gather data on the labor income, production and feed consumption, egg sizes and grades, and management details on poultry farms. Labor studies will be made from the data collected.

The farms contain 32,900 laying birds, and the size of the flocks varies from 500 to 3,200 pullets. Rhode Island Reds, Barred Rocks, and White Leghorns are the breeds represented on the farms. (*Purnell Fund.*)

WHITE PINE WEEVIL STUDIED

The life history of the white pine weevil and methods of control, both direct and indirect, were studied by C. C. Plummer and A. E. Pillsbury and published during the year as Bulletin 247. In brief, the life history of this most destructive of insect enemies of the white pine is as follows:

The adults leave hibernation about the last of April or the first of May and make their way to the leaders of white pine. Here they feed in the

vicinity of the new growth and tender buds before moving down the leader to feed and oviposit. They are found on the leader until the middle of July, at which time they either die or go to other parts of the tree. The eggs, inserted in the cambium, hatch in from 6 to 20 days. The larvae work their way down the leader, feeding on the inner bark and cambium. After they have fed for three or four weeks each one enters the wood and constructs a pupal cell where it remains for a varying length of time before pupating. The larval stage occupies about 36 days. The pupal stage lasts about two weeks and is followed by the eclosion of the adult. The adults remain within the leader for two or more weeks. After emerging the adults are found feeding on the branches of the white pine in increasing numbers from the middle of September until the middle of October. On the advent of cold weather they hibernate in the duff. Some adults do not die after completing egg-laying but remain alive until a second season when they again lay eggs.

No methods of complete control were developed, although several satisfactory measures for materially reducing infestation in ornamental or commercial plantations were found applicable.

In small plantations the removal of infested leaders just below the farthest point reached by the larvae, a common method of control, must be practiced successively for several years in order to be effective. A marked decrease in the number of weevils may not be noticed until the third year.

Silvicultural control may be brought about (1) by planting white pine in mixed stands with hardwoods or other species of conifers; (2) by planting white pine densely.

In planting white pine in mixed stands the principle involved is to shade the trees sufficiently to reduce weevil attack and at the same time not interfere with the growth of the white pine. The fact that the weevil is a sun-loving insect makes some measure of control by this method possible. The hardwoods or conifers used in the mixture should slightly overtop the white pine during the most susceptible period to weevil attack, that is, until the trees are about 20 feet high. If this practice is followed care must be taken not to let the shade trees overtop the white pine to such an extent that growth of the latter is retarded and the trees become dwarfed and weakened from competition.

Many predators and parasites were found which keep the weevils reasonably well under control. *Lonchoea corticis*, a dipteron predator, is the most important natural control factor in New Hampshire. (*Purnell Fund.*)

KAINIT KILLS MUSTARD IN OATS

Possibilities that mustard, a serious weed in oat fields in New Hampshire, may be controlled by broadcasting finely ground kainit are indicated by experiments conducted by O. Butler and Russell Bissey. Cyanamide proved even more effective, but its nitrogenous quality tends to cause the oats to lodge. Both kainit and cyanamide must be applied when the fields are wet.

Several liquid sprays have also been found effective. When chemicals were used at the following strengths, 90 per cent of the mustard was destroyed: copper nitrate, 1 per cent; sodium bichromate, 1.8 per cent;

sulphuric acid, 2.2 per cent; copper sulphate in 10 per cent sodium nitrate, 2.5 per cent; sodium bisulphate, 3.8 per cent; copper sulphate, 5 per cent; iron sulphate, 15 per cent; ammonium sulphate, 20 per cent; and sodium nitrate, over 20 per cent.

The rate at which the herbicides dry, with one exception, did not materially affect their toxicity to mustard. The exception is iron sulphate which is approximately twice as active when dried slowly.

Since the toxicity of sodium nitrate and ammonium sulphate is markedly affected by the temperature at which the sprayed plants are grown, and iron sulphate varies in effect at different rates of drying, and all these possess a low toxic value per unit of weight, their use as herbicides seems undesirable. Of the remaining materials, if one assumes that all substances having a toxic equivalent of 1 to 5 are equally desirable, a selection may be based on relative cost, ease of handling, and corrosion of spray machinery.

The substances are not equally corrosive. A bright steel nail immersed in the solutions at room temperature for six minutes showed on being withdrawn a deep etching from the copper sulphate, a slight etching from the sulphuric acid, and no visible effects from the copper nitrate, copper sulphate, sodium bisulphate, and sodium bichromate. Four of the most effective sprays have little or no action on iron. Copper nitrate, however, is too expensive, but copper sulphate and sodium nitrate mixed, sodium bisulphate, and sodium bichromate are giving promise as very desirable herbicides. (*Hatch Fund.*)

MOSQUITO SURVEY MADE

The white-marked salt-marsh mosquito is the worst of the five most important mosquito species found on the New Hampshire seacoast by P. R. Lowry. After the middle of July it became the dominant form outnumbering all the other species combined, and remained until killed by frost.

Descriptions of this and 37 other varieties of mosquitoes found in New Hampshire were published during the year in Bulletin 243, "Mosquitoes of New Hampshire." Investigational work was conducted principally at Rye and North Hampton.

The greatest natural enemy of the salt-marsh mosquito is the killifish, or mud minnow (*Fundulus heteroclitus L.*) In pools reached by the incoming tide it devours mosquito larvae and pupae before they can complete their growth. (*Hatch Fund.*)

EXPERIMENTS IN COOLING MILK

When milk is cooled in the can by immersion in a refrigerated tank of water the tank should contain approximately three to five gallons of water to each one of milk being cooled, finds W. T. Ackerman in testing the relative efficiency of various methods of cooling milk. Many tanks are now deficient in this respect and cool too slowly.

Pre-cooling by circulation of well water at 51 degrees Fahrenheit through a tubular aerator will reduce the milk to a temperature as low as 52½ degrees and has been accomplished at a cost of 25 cents for 100 quarts

of milk including storage for one day. Subsequent storage in 40-quart cans in a wet tank having 2-inch cork insulation was accomplished at an average expenditure of 2.2 kwhs. a day during a period between October and June for 100 quarts of milk.

In three dry-storage rooms on experimental farms in the state, costs of cooling 100 quarts of milk were 1.35 kwhs., 2.07 kwhs., and 2.65 kwhs., the average being 2.02 kwhs., slightly less than for the wet-tank method. The dry storage having the highest power demand for cooling, however, is of apparent faulty construction, and, if eliminated from the averages, the

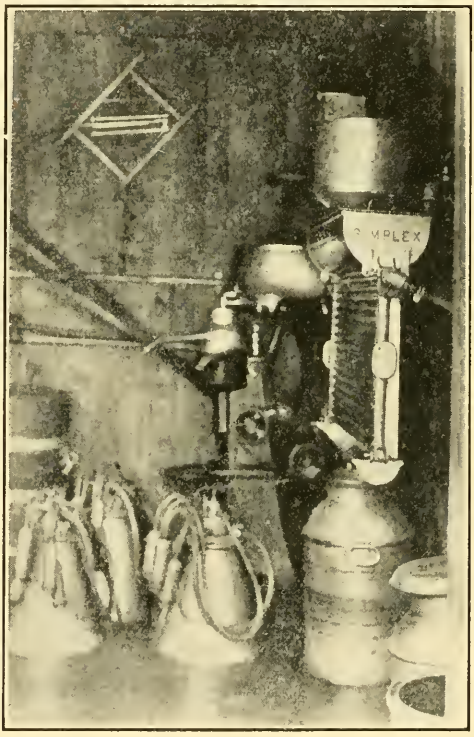

FIGURE 3.—A corner of a milk room showing one of the types of pre-coolers being used on experimental farms.

cost of cooling by the dry storage method is found to require .8 kwh. a day less for cooling 100 quarts of milk.

Pre-cooling by circulating well water with a motor-driven pump on one experimental farm was accomplished at a cost of .8 kwh. of electricity for 100 quarts of milk a day. This cost is one-third less than was obtained in later tests at the station and indicates that size of motor and pump, temperature of water, rate of circulation of water, rate of flow of milk, etc., affect the costs and prevent conclusions being made. Further tests are underway. (*Purnell Fund.*)

FINDING THE ENERGY AND PROTEIN CONTENT OF FOODS

Analyses of food samples available in Durham and surrounding communities were made by A. Gertrude Farr in coöperation with Dr. Francis G. Benedict, director of the Nutrition Laboratory of the Carnegie Institution of Washington.

Five-cent packages of sandwiches, sold in waxed paper and consisting of crackers with various fillings, were found to contain nearly 200 calories each, or as much energy as the average 10-cent fresh sandwich. Fifteen-cent servings of ice cream averaged about 200 grams in weight, 500 calories of total energy, and 7 grams of protein. The energy value per 10 cents of sundaes from drug stores was about 250 calories, nearly 100 calories less than in ice cream.

On an average 450 calories for 10 cents can be obtained in the popular candy bars selling for 5 or 10 cents. Five-cent bags of salted peanuts furnished 13 grams of protein each, proving to be one of the more economical sources of protein.

Thirty-four dinners from the college cafeteria furnished from 517 to 1,610 calories and from 10 to 60 grams of protein each, not including the butter and beverage. Twenty-nine dinners from three commercial restaurants in Durham contained 456 to 805 calories and 19 to 43 grams of protein. Assuming that butter and a glass of milk were taken with these meals, the calories for 10 cents ranged from 165 to 410 at the cafeteria and from 145 to 245 at the restaurants, and the protein content for 10 cents varied from 4 to 15 grams and from 6 to 11 grams, respectively.

Twenty-two suppers selected at the cafeteria varied in energy and protein content for 10 cents in much the same manner as the dinners. Food combinations served at the other restaurants at night yielded from 70 to 385 calories and from 2 to 13 grams of protein for 10 cents.

The data on mixed meals indicate that the energy value of the total food consumed a day, a week, or for any period of time, may be estimated with a relatively high degree of accuracy by obtaining the air-dry weight of a food mixture and multiplying it by the factor 5. This procedure does away with the necessity of using either the bomb or the oxy-calorimeter and gives the physician or the dietitian a simple means of calculating the energy intake with a degree of accuracy sufficient for most purposes.

Samples of the food wastes of students at a local sorority house were collected and analyzed. An average of 51 grams of air-dried material was wasted each day by student No. 1; 26 grams by No. 2; 44 grams by No. 3; and 94 grams by No. 4. (*Purnell Fund.*)

A STUDY OF PARALYSIS IN POULTRY

Blood counts and chemical analyses of the blood of ten paralytic and fourteen normal chickens, and chemical analyses of the bones of five normal and five paralytic birds, were made by C. L. Martin and F. S. Schlenker. The phosphorus and calcium contents of the blood of the paralytic birds were found to be lower than that of normal birds. The blood of the paralytics contained 59 per cent as much calcium and 82 per cent as much phosphorus as that of normal birds.

The calcium and phosphorus content of the bones of paralytic and normal birds was the same.

Blood counts show that the hemoglobin (oxygen carrier of the blood) in blood of paralytic birds is less than normal. Of the different kinds of white corpuscles, the lymphocytes are most numerous, denoting the presence of an infection. The white corpuscles which overcome infection, the polymorphonuclear leucocytes, are fewer in the blood of paralytic birds. That the formation of blood cells in paralytic birds is being seriously disturbed is shown by the decreased content of mast and eosinophiles cells.

Groups of birds were fed three rations which differed only in the content and source of cod-liver oil, and analyses of the calcium and phosphorus content of the blood were made. There was practically no difference in the phosphorus content of the samples. The calcium content, however, differed. The birds fed a ration containing a combination of 1 per cent cod-liver meal and 1 per cent cod-liver oil had the highest calcium content in the blood; the 1 per cent cod-liver meal-fed group contained 10 per cent less, and the 1 per cent oil-fed group contained 25 per cent less. (*Purnell Fund.*)

VACCINATING POULTRY TO PREVENT FOWL-POX

Fowls vaccinated two years previously to prevent fowl-pox were found by C. L. Martin and C. A. Bottorff still to be immune to artificial infection.

Further field tests in 25 commercial poultry flocks show best results are obtained from skin vaccinations when flocks are vaccinated three to six weeks prior to coming into egg production. Flocks vaccinated after coming into production suffered a severe setback. In the more severe cases the reaction lasted three to six weeks, production returning to normal in five to eight weeks.

Six flocks containing 15,000 birds were vaccinated by the "Johnson stab method." It was found that the percentage of "takes" by this method is equal to that of any other, that birds can be vaccinated about three times as fast as with the follicle method, that only one-third as much vaccine is required as for the follicle method, that fewer head lesions are observed, and that the vaccine is more easily applied.

A report of laboratory and field tests on "Vaccinating for the Prevention of Fowl-Pox," by E. M. Gildow and C. A. Bottorff, is published as Station Circular 30. (*Purnell Fund.*)

COD-LIVER MEAL PROVES SUPERIOR TO COD-LIVER OIL

Cod-liver meal proved superior to cod-liver oil in the rations of both young chicks and mature pullets in its effects on growth, amount of pigmentation, and fertility and hatchability of the eggs produced, in a series of feeding tests conducted by H. O. Stuart and T. B. Charles.

At seven weeks of age, a lot of 75 chicks fed 2 per cent of cod-liver meal attained an average weight of 19.11 ounces, almost two ounces more than the average of a lot fed 1 per cent cod-liver oil. The lot fed 2 per cent cod-liver oil weighed on the average 15.82 ounces; 3 per cent cod-liver oil-fed chicks weighed 13.81 ounces, and 4 per cent oil-fed chicks weighed 15 ounces. Poorer growth results were obtained from excessive oil feeding, the development was slower and less uniform, and less pigment was contained in the birds. Paleness of the shanks was very apparent in the oil-fed lots.

The feed consumption of the meal-fed chicks was greater than for the oil-fed ones; 78.14 ounces of feed per chick were consumed by the meal-fed chicks during the period of the experiment, compared to 45.75 ounces for the 1 per cent, 42.72 ounces for the 2 per cent, 45.42 ounces for the 3 per cent, and 52.07 ounces for the 4 per cent oil-fed.

The hatchability of eggs from 150 meal-fed breeding pullets was 10 per cent greater than those from a similar number from the oil-fed. The percentages are 74.6 and 64.3, respectively. Of fertile eggs set the hatchability percentages are 84.3 and 75.4. (*State Fund.*)

FRUIT BUD FORMATION

Effect of Fertilizer and Cultural Treatments

A summary of yields for the second decade in the Woodman apple orchards, by G. F. Potter, discloses that larger crops have been obtained from the plot that has been cultivated, cover-cropped, and given extra nitrogen in a complete fertilizer. The ten-year average yield per tree in the plot given this treatment is 337.6 pounds of fruit. The second highest yielding plot, which produced 270 pounds of fruit per tree, has received a complete fertilizer and is cultivated and cover-cropped each year.

The other eight fertilizer and cultural treatments in order of their effectiveness are: cultivation and cover-cropping plus a complete fertilizer with extra phosphorus, 240.3 pounds per tree; cultivation and cover-cropping plus a complete fertilizer, 232.7 pounds; clean cultivation plus cover-cropping, 231.3 pounds; cultivation and cover-cropping plus a complete fertilizer with extra potash, 229.1 pounds; clean cultivation without a cover crop, 216.9 pounds; and two plots which were cultivated alternate years and received no cover crop, 150.6 and 92.3 pounds; and sod treatment, 74.6 pounds.

Random counts indicate that fruit bud formation is not changed as materially as is yield by the different cultural and fertilizer treatments. Only the plots which received no fertilizer and were inadequately tilled showed a material reduction in the proportion of spurs producing blossoms. The increase in production is due, rather, to a greater production of fruiting wood and a correspondingly larger number of spurs. It is noticeable, however, that a larger proportion of spurs produced blossoms at two years of age in the highest producing plot.

Given the same amount of nitrogen as the tilled plot the plot in sod in the renovated orchard of the university farm produced 127.8 pounds of apples per tree less than the tilled trees. These figures are averages of the seven-year period of 1923 to 1928. The cultivated plot produced 390.9 pounds; and the sod plot, 263.1 pounds.

Effect of Time of Fertilizing

Data from an experiment in its third year, to find the effect on fruit bud formation of splitting the fertilizer application, indicate that the set of blossoms has been increased slightly by means of the divided application of nitrogen. Similarly, there seems on the whole to be a tendency for the yield to be slightly greater for the trees receiving the mid-summer application, although the difference is small and was not apparent in 1929 in the Baldwin orchards. There has been no appreciable effect on the percent-

age of spurs forming blossom buds. In the split application one-half is applied in the early spring and the balance in mid-summer.

Time of Formation

An extensive study of the period during which flower primordia are initiated in the Baldwin and McIntosh apple, by E. J. Rasmussen, shows quite definitely that in 1928 blossoms were initiated in the McIntosh variety during a period of two or three weeks, commencing about the third week in July. The Baldwin flower buds made their appearance over a similar period, commencing the first week in August. This indicates that while previous investigators have shown that the earliest flower buds may be detected in early July, the bulk of the differentiation of these two varieties occurs later. (*Adams Fund.*)

PRUNING APPLE TREES

At ten years of age there appears to be no significant differences in sizes of fruit or crop, and no difference in the amount of breakage occurring, among the vase, semi-leader, and full-leader forms of pruned trees. The average diameter of the trunk of the semi-leader form is 5.46 inches; of the full-leader, 5.33 inches; and of the vase form, 5.27 inches. In the same order the pounds yield from each form of tree are: 210.6; 202.5; and 190.4. The variety of the trees is McIntosh. (*Hatch Fund.*)

TESTING VARIETIES OF FRUITS

About twenty trees of the Cortland variety planted in 1923 in the fruit variety test blocks bore a first crop in 1929. The yield was not large, although it was probably as great as might be expected of McIntosh trees of similar age and, accordingly, much more than would be expected from the Baldwin variety. The fruit did not attain an especially attractive shade of color, but on the whole contained more red pigment than the Baldwin. The Cortland appears worthy of further trial as a late variety to be used in place of Baldwin, since the market value of the latter appears to be steadily declining.

The sod test orchard, planted in 1923 to compare Golden Delicious, Wealthy, Red Delicious, and Baldwin varieties, bore a few scattered fruits in 1929. Wealthy, Golden Delicious, and Delicious trees are all making a splendid growth under this system of culture. The Baldwin made the least satisfactory growth of the four.

In the peach orchards the Hale produced the heaviest crop per tree of the four varieties under test. Usually this variety is considered a scant producer. The crop of Elberta, after the relatively mild winter of 1928–29, was larger than that of Carman, which is very unusual under New Hampshire climatic conditions. (*Hatch Fund.*)

PHOSPHORUS FAILS TO AFFECT POTATO YIELDS

No distinct differences in yield were noticeable in potato plots which received eight separate treatments of phosphorus fertilizers. Northern grown certified Green Mountain seed was used. The total amount of stem growth in inches was measured on fifteen representative plants in

each plot, and early in the season a distinctly larger amount of growth was attained by plants in the plots which received a considerable amount of acid phosphate. Later in the season, however, these differences tended to disappear. J. R. Hepler conducted the experiment. (*Hatch Fund.*)

PARSNIPS RESPOND TO FERTILIZERS

Experiments by J. R. Hepler on soil fertility in the garden clearly indicate that parsnips respond both to commercial fertilizer and stable manure. Limed plots also showed an increased yield of 16 per-cent over the unlimed. The increase from lime was consistent on all plots and was greatest when little fertilizer was used. The largest yield was obtained from the plot receiving 24 tons of manure, 150 pounds tankage, 100 pounds nitrate of soda, 600 pounds acid phosphate, and 150 pounds muriate of potash to the acre. The second highest yield was obtained from the plots which received 16 tons of manure, 250 pounds of tankage, 160 pounds nitrate of soda, 800 pounds acid phosphate, and 300 pounds muriate of potash to the acre. Thirty-two tons of manure to the acre gave the third highest yield. (*Hatch Fund.*)

CODLING MOTHS TRAPPED

A check-up on insect injury in apple orchards in the fall of 1929 indicates that in individual orchards the number of moths caught in alcoholic traps in the spring determines the advisability of using a cover spray for codling moth. Where only an occasional moth was caught during the season little codling moth injury occurred later in the orchard. When ten or more moths were caught at the same time a spray proved very worth while.

Moths were found in the plots at the first examination June 12, in orchards at Hollis, Greenland and Lyndeboro. The moths continued to emerge throughout the months of July and August, but no definite peak of emergence occurred. From July 1 to July 20 the number of moths caught gradually increased, and then remained more or less constant until August 20, when the emergence declined rapidly. Only a few were caught after August 25. The traps were set up and visited by E. J. Rasmussen. (*State Fund.*)

FINDING POLLINIZERS FOR MCINTOSH

The Delicious variety maintained its place as a most reliable pollinizer for McIntosh during the 1929 season, according to the hand pollinations made by L. P. Latimer. This variety was surpassed only by Red Astrachan and Williams. Other satisfactory varieties were Cortland, Oldenberg, and Wealthy. Gravenstein pollen gave an unsatisfactory set and Baldwin again proved of no value.

The relatively low amount of set from the Wagener pollen, in contrast to the excellent results previously obtained, is explained by very cold weather during the Wagener pollination period. On one day pollinizing with Wagener did give by far the highest set.

Little or no difference in the size of the McIntosh fruit resulted from the different crosses. There were, however, significant differences in the

number of seeds produced. The varieties of pollen that produced the smallest set of fruit produced only about one-half the number of seeds in the mature fruit, and nearly 50 per cent of the apples were lopsided. McIntosh pollinated by Delicious and Oldenberg gave only 5 and 9 per cent lopsided fruit.

Of all the fruits harvested from two McIntosh trees, about 60 per cent were produced from lateral flowers on the cluster; the remaining 40 per cent came from the terminal flowers. (*Purnell Fund.*)

A STUDY OF FRUIT IN STORAGE

A study of the changes occurring in Baldwin apples during storage was continued by L. P. Latimer. Duplicate lots of large and small apples were stored in common storage in Wilton and cold storage in Manchester. At Manchester a temperature of 31 to 32 degrees Fahrenheit was maintained throughout the season. The temperature at Wilton varied from 28 to 34 degrees.

Apples tended to ripen more rapidly in common storage. Large apples again colored up more rapidly than small apples in both storages, and there was a tendency for all apples to lose weight slightly and to decrease slightly in diameter.

A slight decrease in the electrical resistance of the fruit tissue occurred until February 2, when a slight rise in resistance continued until April, which was followed by a rapid rise in electrical resistance amounting to 10 per cent by May 1. There was a slight tendency for common stored apples to show a rise in electrical resistance before cold stored fruit. On an average the electrical resistance of the juice of small apples was 15 per cent greater than for juice of large apples, indicating a larger amount of ionizable substance in the larger fruits which were generally of better quality.

There was a decrease in the freezing point depression of the juice between January 12 and February 2, amounting to 5 per cent. No further change occurred until April 1, when a rise began which reached 10 per cent by May 1. During this same period there was a decrease in sucrose content of 50 per cent.

Respiration measurements indicated little difference between the effects of common and cold storage. (*Purnell Fund.*)

ARSENIC RESIDUES ON APPLES

Three applications of a cover spray of an arsenical poison on apple trees, even under the conditions obtaining in the relatively humid climate of New Hampshire, led to a considerable proportion of the fruits showing more arsenical residue than is tolerated under the pure food and drug laws. Over a period of two years analyses also indicate, other things being equal, that lead arsenate adheres to the fruit in larger quantities than calcium arsenate.

Apples were selected for analysis from the four quarters of the tree and, with the exception of the east side where the amount of residue appeared to be less, no significant differences in the amounts of residue were found. The exception is due, it is thought, to the failure of the sprayers to obtain a complete cover against prevailing winds. Fruits on the lower branches

of the trees were found to carry a larger amount of residue than those on the upper branches.

A close correlation exists between the amounts of arsenic present and the quantity of lead residue, although the amount of lead recovered is slightly less than would be expected in combination with the amount of arsenic present.

Slightly over 23 per cent of the apples receiving three sprays of arsenate of lead, at the rate of two pounds to 50 gallons of spray, contained enough arsenical residue to exceed the tolerance. Calcium arsenate used at 1½ pounds to 50 gallons of water left a residue which exceeded the tolerance on 12.78 per cent of the apples. None of the apples given one spray of lead arsenate contained an excess of arsenic; calcium arsenate in excess of the tolerance remained on two per cent of the apples given one spray. Thirty-four per cent of the apples given three sprays, and 6.25 per cent of the apples given only one cover spray, contained a residue of lead in excess of the tolerance.

The analyses were made by S. R. Shimer, G. P. Percival, and A. D. Robinson under the direction of T. G. Phillips. G. F. Potter directed the spraying. (*Purnell Fund.*)

PREVENTING FUMIGATION INJURY IN GREENHOUSES

The composition of the Bordeaux mixture used on greenhouse plants before fumigation with cyanide is found by R. R. Jenkins and O. Butler to have a marked effect on the severity of injury from fumigation. Mix-

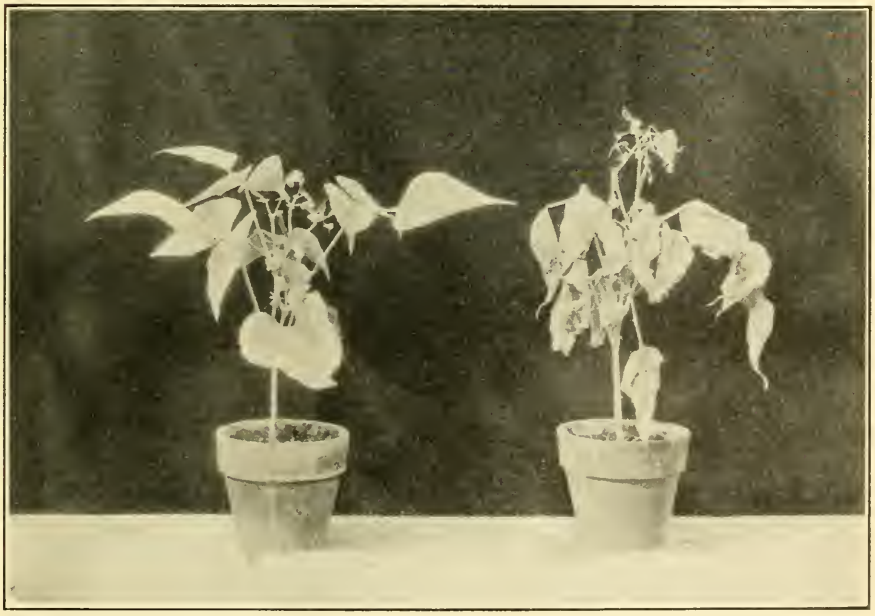

FIGURE 4.—Both of these plants were sprayed with the same materials and then fumigated. Later the one at the right was wetted, and the one at the left not. Wetting was not found injurious, however, when a neutral Bordeaux mixture was used.

tures were used with the following ratios copper sulphate to quick lime: 1:02 (neutral), 1:05, 1:1, 1:2, 1:4, 1:6. A neutral mixture or a very slightly alkaline wash is the only one that can safely be used.

The cause of the injury is due to the formation of cupric cyanide which decomposes with the liberation of cyanogen in the case of those mixtures which are toxic when the foliage is not wetted, or to the formation of an alkaline double cyanide in the case of the mixtures which show toxicity when wetted or increased toxicity on being wetted.

Sunflower, tomato, bean, cucumber, castor oil and potato plants were used. Results are discussed in Scientific Contribution 25. (*Adams Fund.*)

MORE SPRAYS FOR APPLE SCAB

In 1928, for the first time in several years, four sprayings for apple scab were found by O. Butler to be essential to commercial control. Control probably could have been improved by a fifth spraying. The production of A-grade fruit from the trees sprayed three times was 25 per cent, compared to 66 per cent from the trees sprayed four times. Lime-sulphur solution, 1 to 50, was used throughout, and at the prepink and calyx applications calcium arsenate was added for insect control in one series of experiments at the rate of 1½ pounds to 50 gallons and in the other at ¾ pound to 50 gallons. Both strengths of calcium arsenate gave satisfactory insect control. (*Hatch Fund.*)

EUROPEAN CORN BORER STRAINS MEET

The two-generation phase and the one-generation phase of the European corn borer are now making contact in the western part of the state, finds W. C. O'Kane. The former phase occupies the generally infested area of New Hampshire, having spread from the original infestation in Massachusetts. The one-generation phase originated near Schenectady, N. Y., and has spread across eastern New York and southern Vermont.

Although no one can predict the outcome of the contact of the two phases, theoretically the population of the borer in New Hampshire might become more dense if the state were infested with a vigorous, one-generation strain. Present evidence still suggests that the two-generation tendency of the specimens now generally present in the state works to their disadvantage because of the shortness of the growing season. (*Adams Fund.*)

BREEDING SHEEP

Constant inbreeding over a period of 15 years, during which no outside blood was introduced for seven generations, has resulted in a material decrease in size of sheep. This has resulted despite a constant elimination of undersized offspring from year to year. There has been no inhibition of fertility, however, and the percentage of twins born in the later generations has increased which in part may be responsible for the decrease in size due to a lack of sufficient milk to support two lambs.

A considerable number of crosses have been made between multiple nippled sheep in an effort to establish a strain which possesses four functional nipples. While a higher milk yielding capacity seems to be asso-

ciated with the multi-nipple trait the majority of the offspring possess only two functional nipples. So far six female offspring having four functional nipples have been obtained.

Further data obtained on the effect of crossing coarse wool and fine wool breeds support the earlier conclusions that when extremes are crossed there results dominance of neither fine nor coarse wool. In the recent crosses somewhat greater extremes in parent stock were used than heretofore, one-half bloods being crossed with quarter bloods. It has become apparent that attempts to improve the quality of wool require constant selection and careful weeding out of undesirable characters if the intermediate characters are to become stabilized as blends which will be transmitted as such.

All sheep breeding experiments are in charge of E. G. Ritzman. (*Adams Fund.*)

METABOLISM OF MILCH COWS

Following ten years of study with dry cows and steers a study of the insensible perspiration of milch cows, or daily loss in weight due to excretion of carbon and water vapor through the lungs and skin, was begun in 1928 by E. G. Ritzman in coöperation with Dr. Francis G. Benedict, director of the nutrition laboratory of the Carnegie Institution of Washington.

Insensible perspiration is significant in two respects—its probable correlation to general metabolism which already has been found to exist in humans, and its value in establishing the water balance of animals under different conditions of feeding.

Results indicate that insensible perspiration is the safety valve by which the animal eliminates excess heat under high pressure of metabolism. Daily changes in the amount of feed consumed, in humidity, and in environmental temperature invariably reacted on the insensible perspiration without a corresponding change in the milk flow.

The cost of digestion in terms of energy consumed was measured for two dry, farrow, Holstein cows both of which had been record producers. The cost of digestion, as represented by the difference in metabolism on full feed and the second fast day, equalled 55 per cent of the fasting metabolism in the case of one animal and 60 per cent in the case of the other. The difference was largely due to a difference in basal requirement, the actual cost of digestion measured in calories being almost identical—4,030 and 4,860.

The rations used were in sufficient amount to supply maintenance, as follows: 5 kgs. hay; 2 kgs. beet pulp; and 1 kg. linseed oil meal. (*Purnell Fund.*)

ELECTRIC HOUSEHOLD REFRIGERATION

On six of the seven experimental farms in the New England rural electrification project, electric household refrigeration was studied by W. T. Ackerman. The refrigerator proved one of the most desirable pieces of electrical equipment for farm homes in the opinion of all the farmers and their wives.

Two general types of equipment were studied. One type was in com-

bination with the electric dairy cold storage; the others were individual household refrigerators. The latter type may be further divided into three divisions—the modern commercially built single cabinet unit, the commercially built refrigerator converted to electric refrigeration, and the home-made refrigerator converted to electric operation.

Comparisons of costs with the ice method of refrigeration were made. Investment in equipment was higher for the electric method, being $370 compared to $282 for ice equipment. The total fixed charges were $12.15 for ice and $18.20 for the electrical method. The house and dairy needs on one farm were met with an expenditure of $766.50 for a single combination unit. Compared with $885.80 and $889.34 on two other farms for separate sets of equipment for house and dairy this represents a saving of $120 and $225 in favor of combination equipments.

In the amount of current consumed variations between .0016 kwhs. and 008 kwhs. per cubic foot of total box capacity per hour occurred. The locations of the compressor and refrigerator were found to have an important influence on cost of operation. The maximum consumption for the year was 514 kwhs., and the minimum consumption was 151 kwhs.; the average for all machines being 385. The combination method was found to require 30 per cent less current for the year than the separate unit method.

Current consumption on the five standard type refrigerators averaged 41 kwhs. per month. The average maximum consumption was 67 kwhs., and the average minimum consumption, 100 kwhs. Compresser units operated 19 per cent of the time.

Total annual costs for using ice had previously averaged $41.63 per year, a daily average of 21 cents.

Details of the experiment are given in Bulletin 244, "Electric Household Refrigeration." (*Miscellaneous Income.*)

CERTIFICATION OF POULTRY

In its second season the demand for service in poultry certification increased 80 per cent. In the season of 1928–29, fifty-one poultry growers secured the aid of H. O. Stuart in selecting breeding stock from 39,823 birds. Only accredited flocks are given certification. The purpose of the work is to separate the hens into three classes depending on their ability to produce chicks having the qualities needed for high egg production. A charge of three cents a bird is made to cover partly the expense of this specialized poultry work.

Birds of satisfactory production qualities and color which are free from evident heritable disqualifications are certified and placed in Class I. Class II contains birds desirable for egg production purposes. These birds are off color, have one or more disqualifications, or have poorer production ability. Into Class III are placed cull birds which are unfit for economical egg production or breeding purposes. (*Miscellaneous Income.*)

SOIL FERTILITY STUDIES

Experiments in soil fertility, now entering their sixth year, are being conducted on carefully selected sites representative of New Hampshire soils. Five series of investigations, which are being supervised by F. S.

Prince and T. G. Phillips, deal with growing hay on neglected hay lands, growing legumes on old hay lands, dairy farm rotations on old hay lands, potatoes in a three-year rotation, and legume experiments in the Connecticut Valley. The plots are located on the Carter Farm at Boscawen, the Whenal Farm at Greenland, the Jackson Farm at Colebrook, and the Livingston Farm at Claremont.

On Neglected Hay Lands

The season of 1929 was one of deficient rainfall, and the yields of the 63 plots on the neglected hay lands on the Whenal Farm in Greenland were considerably less than in 1928.

Nitrate of soda failed to give a significant increase either on the old sod or on the manured plots, but the unmanured plots responded significantly. Super-phosphate failed to give significant increases either on the manured or unmanured plots. It is now evident that the available phosphorus content of this soil is ample for the normal production of timothy hay after a stand once has been secured. When used together, nitrate of soda and super-phosphate gave a significant increase, but this response is in the main due to the nitrogen rather than the phosphorus in the mixture.

Fertilizing Alfalfa

During the fall of 1928, a season of heavy rainfall, the alfalfa on the 48 twentieth-acre plots on the Whenal Farm was attacked by leaf spot disease which weakened the plants. This was followed by an open winter with little snow and much ice which reduced the stand, although quite uniformly. Chemical fertilizers were applied about May 1, 1929. No manure or lime has been applied since the original application in May, 1926, when all plots received a basic application of 20 tons manure and 2 tons of limestone an acre.

All treatments significantly increased the size of the first cutting, except 2 tons limestone and 100 pounds nitrate of soda, while in the second cutting all increases are significant except those which resulted from: 100 pounds nitrate of soda; 2 tons limestone; 500 pounds of super-phosphate; or 2 tons limestone and 500 pounds super-phosphate. The other, more successful treatments on an acre basis: 150 pounds muriate of potash; 20 tons manure; 20 tons manure and 2 tons limestone; 20 tons manure and 500 pounds super-phosphate; 20 tons manure, 2 tons limestone and 500 pounds super-phosphate; 20 tons manure, 2 tons limestone, 100 pounds nitrate of soda and 500 pounds super-phosphate; 20 tons manure, 2 tons limestone, 500 pounds super-phosphate and 150 pounds muriate of potash; and 20 tons manure, 2 tons limestone, 100 pounds nitrate of soda, 500 pounds super-phosphate, and 150 pounds muriate of potash.

Analyses of the second cuttings of alfalfa were 2 to 4 per cent higher in protein than analyses of first cuttings.

Fertilizing Sweet Clover

On the sweet clover plots significant increases were obtained from treatments of 2 tons limestone and 500 pounds super-phosphate in combination; 20 tons manure and 2 tons limestone; 20 tons manure and 500 pounds super-phosphate; 20 tons manure, 500 pounds super-phosphate, and 2 tons limestone; and from 20 tons manure, 2 tons limestone, 500 pounds super-phosphate, and 150 pounds muriate of potash.

Fertilizing Potatoes in Rotation

Variations in the nitrogen content of the fertilizers produced smaller fluctuations in yield of potatoes than variations in phosphorus and potash, in an experiment embracing 60 twentieth-acre plots testing potatoes, oats, and clover and timothy three-year rotation at the Jackson Farm near Colebrook. Potatoes on this farm seem to be quite sensitive to phosphorus; those plots which had received 1 ton of 5-0-7 grade fertilizer yielding 72 bushels less than the checks while those receiving 1 ton of a 5-16-7 grade showed a gain of 61 bushels an acre (the check plots had received one ton of 5-8-7 fertilizer).

Still, while the soil does not seem to have sufficient potash, an additional amount over the standard 7 per cent application did not increase the yield to a significant extent.

The yields of oats were very variable, indicating that cultivation of the land during the wet 1928 season affected the crop.

Both 2 and 4 tons of limestone gave significant increases on the mixed clover and timothy hay in this rotation. There were no other variations in treatments on the 1929 hay crop. (*Purnell Fund.*)

Potatoes Need Potash

When potatoes are grown on old, neglected lands 10 per cent of potash in the fertilizer is none too much, finds F. W. Taylor. In previous years, when fertilizer tests were conducted on lands in good state of fertility, 3 to 6 per cent of potash seemed ample.

Data on yields were obtained from plots treated with fertilizers varying in potash content from zero to 10 per cent, while the amounts of nitrogen and phosphoric acid remained constant. The land was a sandy loam sod and had not been plowed, manured, or fertilized for twenty years. Certified Green Mountain seed from New Brunswick was used.

The average yields per acre for each treatment over a seven-year period are: for the check, 168.7 bushels; 4-8-0 fertilizer, 224.3 bushels; 4-8-3 fertilizer, 248.5 bushels; 4-8-6 fertilizer, 262.9 bushels; and for the 4-8-10 fertilizer, 266.5 bushels. Fertilizer was applied at the rate of 1,500 pounds to the acre in each case.

Method of Applying Fertilizer to Potatoes

For the third consecutive year placing the fertilizer widely in the row with the seed at planting time has given better results than placing above, below, or at the side of the seed. Fifteen hundred pounds of 4-8-4 fertilizer were used, and the seed pieces were set one foot apart in rows three feet apart. The average yield for the three years, when fertilizer was placed with the seed, is 265.1 bushels to the acre. Placing below the seed gave the second highest yield—255.6 bushels—at side of seed third, and above the seed the poorest yield.

Manure Proves Worth in Potatoes

That manure at the rate of 12 tons to the acre is worth $3.75 a ton, is indicated by a three-year average of the increased yield multiplied by the current price of potatoes. In 1929 an application of 12 tons of manure increased the yield 75.6 bushels over no manure, and 24 tons increased it 107 bushels. These findings are in accord with the general theory that

frequent light applications of manure result in its more economical use than infrequent heavy applications.

Nitrate vs. Sulphate in Fertilizing Potatoes

Two years of results of tests of the relative effectiveness of nitrate and sulphate fertilizers as a source of inorganic nitrogen for potatoes indicate, both from a standpoint of total yield and size of tubers, that sulphate alone is not quite as desirable as nitrate alone and that neither alone is as good as a mixture of the two. The plots treated with the mixture yielded ten bushels more to the acre than the nitrate plots and twelve bushels more than the sulphate plots.

Very little difference was noted in the yields from plots fertilized with 450 pounds of concentrated 16-32-16 fertilizer and plots treated with 1800 pounds of the 4-8-4 grade. (*Hatch Fund.*)

TEMPERATURE AND THE PRODUCTION OF SEED POTATOES

A close correlation exists between temperature and the appearance of mosaic symptoms in potato stock, finds O. Butler. A low mean daily temperature is favorable for mosaic, and a high daily mean temperature is unfavorable. A high mean daily temperature accompanied by temperatures above 25 degrees Centigrade causes a masking of mosaic symptoms; and the number of hours the temperature remains above 25 degrees Centigrade seems to be particularly significant when the mean daily temperature for the growing season is above 17 degrees.

The experiment is in its sixth year, and in the years that the mean temperatures at Colebrook and East Kingston were approximately the same the mosaic readings were nearly alike in the two widely separated plots. Difficulty has been experienced in preventing deterioration of the stock from leaf-roll at East Kingston. On the Irish Cobbler plots this was effectively done by early harvesting.

In 1928 an experiment was begun to determine the value of early harvesting in checking leaf-roll with the Green Mountain variety. The stock planted produced plants showing 6.40 per cent mosaic and .56 per cent leaf-roll. Following the first inspection the field was rogued, and, as the season was unusually cool for the locality, the roguing for mosaic was thorough. Potatoes harvested at 81 days after planting showed no mosaic and 6.9 per cent leaf-roll; at 90 days, no mosaic and 3.29 per cent leaf-roll; at 101 days, no mosaic and 2.19 per cent leaf-roll; at 110 days, .24 per cent mosaic and 1.41 per cent leaf-roll; and, finally at 143 days, .21 per cent mosaic and 21.27 per cent leaf-roll.

At Northwood stock was grown in 1927 that showed on the average before roguing 2.78 per cent leaf-roll and no mosaic. Seed saved from this stock was greened before planting in 1928, and 39.3 per cent of the tubers were removed on account of leaf-roll, the diagnosis being verified by actually growing the rejected seed. The remaining seed, presumably healthy stock, was planted, and at the time of the first inspection showed 1.59 per cent mosaic and 35.63 per cent leaf-roll. The climate at Northwood, in temperature characteristics at least, is very similar to that of East Kingston.

Small seed produced plants as free from leaf-roll and mosaic as standard size seed. (*Purnell Fund.*)

GROWING HEAD LETTUCE IN NEW HAMPSHIRE

Iceberg lettuce grown on experimental plots at Lancaster succeeded, while the crops at Colebrook failed, in tests by A. H. Watson of the feasibility of producing solid head lettuce during the summer months under the cool climatic conditions prevailing in northern New Hampshire.

The failure of the crop at Colebrook may have been due to unfavorable climatic conditions of temperature and humidity, or to an unsuitable soil. The troubles encountered at Colebrook are believed in the western lettuce-growing sections to be caused by high night temperatures. The maximum night temperature at Colebrook, however, in 1929 was 68 degrees F., which is probably well within the limit of safety.

FIGURE 5.—One of the plots at Lancaster where the practicability of raising iceberg lettuce is being tested.

At Lancaster on the several plots from 15 to 46 per cent of solid heads were harvested, and the average proportion of solid heads indicates the possibility of a yield of 125 crates of four dozen heads to the acre.

Arrangements had been made at Lancaster to determine the necessity and desirability of irrigating the lettuce crop. The rainfall during the one-hundred day period from May 21 to September 1 was 11.48 inches and reasonably well distributed. The irrigation plant under these conditions was used infrequently and the most water applied to any plot was two inches.

The first iceberg lettuce grown on the experimental plots at Lancaster was shipped to Boston July 19th, by E. H. Rinear. Since Boston is a large terminal market, it was possible to make comparisons with lettuce from other sources. Although the shipments were small and sent at irregular intervals, the results of these trials are encouraging for future development. The lettuce received much favorable comment by the trade and brought a price comparable with that shipped from California.

Through special arrangements with the Express Company, several lots were delivered to the commission house, eight hours after leaving Lancaster. The lettuce had been carefully graded and ice-packed in standard western crates which were lined with wax paper. Because of the prompt delivery and careful packing the lettuce arrived in good condition. It compared well with that from the west as to quality. The heads were nearly as firm as the western, were fresher in appearance, and there was a smaller amount of waste due to icing and russetting of the outside leaves. (*Purnell Fund.*)

TESTING FOR PULLORUM DISEASE

The amount of pullorum disease (bacillary white diarrhea) in New Hampshire is decreasing, according to the results of the blood testing work of the poultry pathology laboratory. The infection present in 124,785 birds in 173 tested flocks was 1.5 per cent in the season of 1928–29 compared to 2.9 in the previous season.

One hundred per cent of the birds in 132 flocks were tested, and 101 of the flocks were found wholly free of the disease. Twenty-seven other flocks which were only partly tested were found to be without reactors to the disease test.

Thirty-seven new names were added to the 100 per cent free list, and 22 flocks were removed. The removals were caused by failure to test, presence of reactors found later to be in the flock, or because of residence outside of the state. Fourteen of the flocks which had formerly attained the 100 per cent free list were admitted to the accredited list on passing the second test.

In all, there are 57 flocks on the accredited list, containing 51,925 birds. Thirty-eight flocks containing 22,330 birds are on the 100 per cent free list.

Testing work is in charge of C. A. Bottorff and C. L. Martin. (*Miscellaneous Income.*)

POST-MORTEM EXAMINATIONS

Post-mortem examinations of birds received at the poultry pathology laboratory indicate that pullorum disease is still the dominant cause of death of chicks in New Hampshire, although the majority of the diseased chicks originated from sources outside the state. Of the 750 chicks examined 321 died of this disease, 204 of which come from sources outside the state to 41 New Hampshire farms. The remaining cases, all from sources in New Hampshire, were found on 32 farms.

Other causes of death in chicks were: pneumonia, 144; "crazy chicks," 47; coccidiosis, 96; vitamin D deficiency, 41; colds, 20; and minor troubles.

In all, 483 adult fowl were examined. Coccidiosis exacted the greatest toll, taking 175 chickens. Fifty-nine died from ruptured egg yolks; pullorum disease caused the deaths of 55; and the paralysis cases numbered 46. Examinations were made by C. L. Martin and C. A. Bottorff. (*Miscellaneous Income.*)

ADVANCED REGISTRY TESTING

Four hundred and sixty-four cows representing 33 farms were on Advanced Registry test under the direction of J. M. Fuller in the period of July 1, 1928, to June 30, 1929. They included 118 Ayrshire Cows, 42 Jerseys, 168 Guernseys, 95 Holsteins, and 41 Shorthorns. (*Miscellaneous Income.*)

TESTING FOR CONTAGIOUS ABORTION

Slightly over 13 per cent of the blood samples of cattle submitted to C. L. Martin of the pathology laboratory to be tested for contagious abortion showed infection. Of the 841 samples tested 112 showed a positive reaction and 38 were suspicious. (*Miscellaneous Income.*)

POTATO CERTIFICATION

Eighty-seven acres of Green Mountain potatoes were entered for certification and 59 acres passed the final inspection. Too high a percentage of mosaic was the principal cause for the disqualification of the rejected fields. Thirty-six acres of Irish Cobbler potatoes were entered and the entire acreage was certified. (*Miscellaneous Income.*)

INSPECTION SERVICE

Seed Testing

The seed testing work for the State Department of Agriculture was carried on as usual, and 386 samples were handled by the laboratory. The results are now being published.

Feeding Stuffs

In connection with the enforcement of the law regulating the sale of concentrated commercial feeding stuffs, 397 of these materials were analyzed for the State Department of Agriculture. These analyses required about 3,300 individual determinations. The results are reported in the annual inspection bulletin.

Fertilizers

In connection with the enforcement of the law regulating the sale of commercial fertilizers, 117 brands were analyzed for the State Department of Agriculture, involving about 800 individual determinations.

Miscellaneous Analyses

Samples of soils, feeds, fertilizers, leaf molds, spray solutions, poisons, etc., have been sent to the Station for analysis. Of these, 177 have been analyzed, involving 225 individual determinations. In addition, 84 color standards for maple syrup were made. (*Miscellaneous Income.*)

FINANCIAL STATEMENT

EXPENDITURES OF THE NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION FOR THE YEAR ENDING JUNE 30, 1929

	Hatch Fund	Adams Fund	Purnell Fund	Supplementary*	Total
Salaries	$9,927.36	$12,344.00	$36,403.76	$16,109.37	$74,784.49
Labor	920.02	930.31	2,516.51	5,017.15	9,383.99
Stationery and office supplies	122.12	6.70	112.43	298.05	539.30
Scientific supplies, consumable	158.43	320.54	815.80	568.72	1,863.49
Feeding stuffs	.....	369.37	226.51	449.58	1,045.46
Sundry supplies	135.61	107.09	504.60	2,127.92	2,875.22
Fertilizers	84.53	146.65	488.67	111.36	831.21
Communication service	595.15	1.02	15.54	115.27	726.98
Travel expenses	461.18	65.64	3,882.89	4,481.16	8,890.87
Transportation of things	307.94	35.50	187.48	238.84	769.76
Publications	995.63	.....	412.70	391.09	1,799.42
Heat, light, water, and power	700.00	.....	.....	.....	700.00
Furniture, furnishings, fixtures	128.63	53.32	855.17	1,030.11	2,067.23
Library	405.59	.....	29.40	281.93	716.92
Scientific equipment	55.57	295.61	1,648.94	20.79	2,020.91
Livestock	.....	.....	492.21	.....	492.21
Tools, machinery, and appliances	2.24	31.33	851.59	1,717.96	2,603.12
Buildings and land	.....	292.92	542.74	745.68	1,581.34
Contingent expenses	.....	.....	13.06	384.60	397.66
Unexpended balance	.....	.....	.....	5,875.65	5,875.65
Totals	$15,000.00	$15,000.00	$50,000.00	$39,965.23	$119,965.23

*This fund includes expenditures from the following sources:

State appropriations	$ 5,500 00
Sales and miscellaneous income	34,465 23
	$39,965 23

THE EXPERIMENT STATION

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Andrew L. Felker
Albert H. Brown, B.S.

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